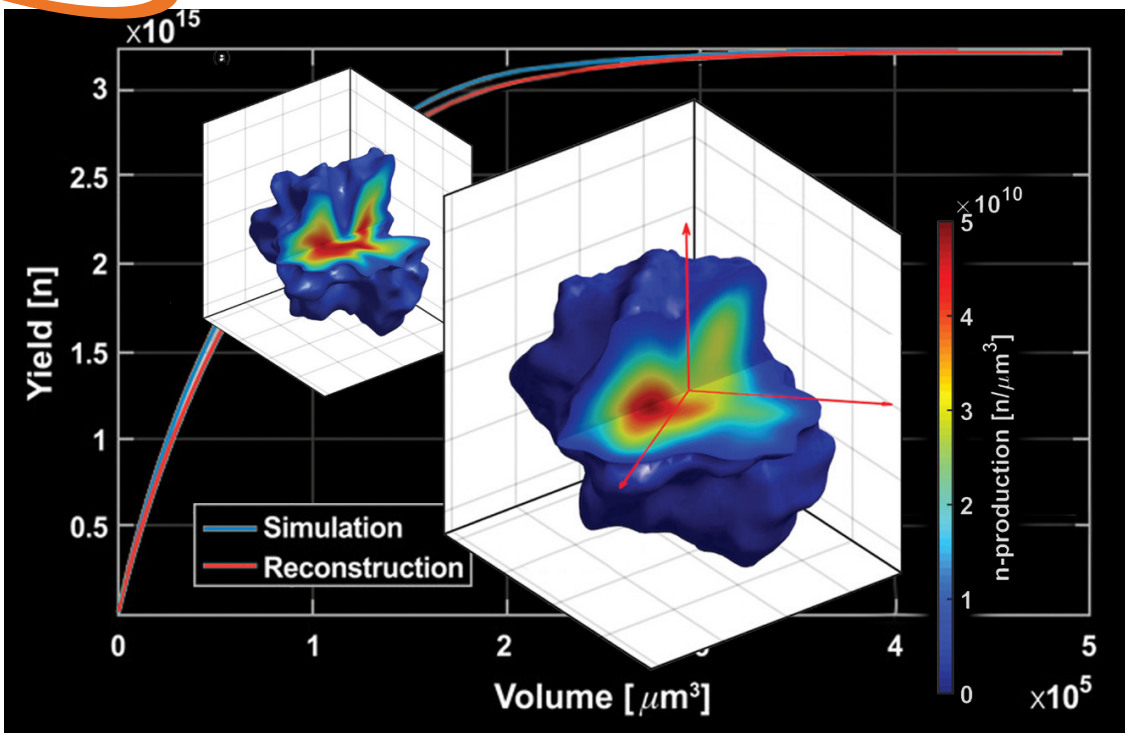
PHYSICS FLASH

Spring 2020

INSIDE



3D reconstruction of an inertial confinement fusion neutron source.

Novel diagnostic reconstructs fuel density distribution during fusion implosions

Has potential far-reaching implications for ICF fusion research

Understanding thermonuclear burn in inertial confinement fusion (ICF) implosions requires understanding the local deuterium/tritium (D/T) fuel density. Understanding this density is a key challenge in fusion research. Fusion ignition holds the promise of producing immense, abundant energy.

Los Alamos researchers and their external colleagues have developed a new method using neutron imaging to obtain previously unavailable information on the density distribution of the DT fuel in an ICF capsule implosion.

Their work, selected as an AIP Scilight and featured on the cover of the *Journal of Applied Physics* (pictured on page 3), represents a completely novel diagnostic quantity for inertial confinement implosions at the National Ignition Facility, which has never before been reported and has the potential to have wide-sweeping impact in the field of ICF fusion.

> The work leverages the Laboratory's unique expertise in neutron imaging diagnostics development and data analysis.

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From Tanja's desk . . .

Dear all,

This week is my seven month anniversary of my time in P Division! Quite amazing to look back at the many things that have happened; of course, with COVID-19 standing out as one of the most unusual situations that I believe most of us have ever experienced. Reminiscing about my time here, I list some very subjectively selected markers (some of them of the "inadvertent" category):

November 2019 – the "oxygen event." It forced us to carefully look at how we are utilizing gas monitoring safety alarms, and a number of inconsistencies came to light that ultimately helped us improve operations as a whole.
November 2019 to January 2020 – team meetings. I met with all the teams and got to meet most of you, giving me a much better—albeit still in need of much refinement—picture of the division.
December 2019 – my first visit to the NNSS, getting acquainted with our U1a work.
December 2019 – creation of the Pu@pRad Performance Assurance Group.
January 2020 – DR pre-proposals. Reading all the pre-proposals (and ultimately the full proposals in April/May) helped me further to learn about P and the exciting ideas that are bubbling up.
January 2020 – the "R2A2 retreat" for pRad, a process still in the finishing touches but mostly completed.
January 2020 – start of the new P Division logo campaign. Winner identified in May.
February 2020 – creation of the new (transient) group P-26.
February 2020 – visit to FNAL where I learned about E1039.
February 2020 – divisional strategic planning started and is now in full swing.
March 2020 – successful execution of Iris.
March 2020 – COVID-19 hit. My planned visit to see our operations at NIF had to be postponed.
April 2020 – present – Working from home!
Late April/May 2020 – We are focusing on resumption of activities.

Of course, many other things happened—proposals got funded, papers got written, and staff members retired, were hired, and were recognized. The above is by no means an inclusive list, it's just a list of things that I was directly involved in.

COVID-19 taught us how to use WebEx, how to make do when we can't meet in person, how to breathe through a few layers of cloth, and not to take bathroom tissue and cleaning agents for granted. Gas prices have dropped significantly, traffic congestion is nonexistent, and the air quality improved considerably, worldwide. We have engineers and physicists from our division actively contributing to fighting COVID-19, all the way from modeling to engineering ventilator attachments using additive manufacturing. I started doing morning walks (due to time saved by not having to prepare for work, make coffee, pack lunch, and drive there) and baking zucchini bread for breakfast on a regular basis. My recipe is quite refined at this point! Our local trails are filled with hikers since no one can travel, people wave to me on the street, and everyone seems to be eager to engage in conversation—despite the six-foot separation. Everyone is hungry for social contact.

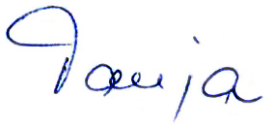
I do have to admit that I like working from home, and I can do most of my work quite efficiently this way. But I do miss seeing my colleagues, sticking my nose in a lab, or bumping into someone in the hallway and hearing what they are up to.

I really look forward to seeing you all in person hopefully soon—wearing a face mask and with overdue haircuts! I invite you to contact me with concerns, questions, and ideas that you may have—or just for a chat letting me know what you are up to!

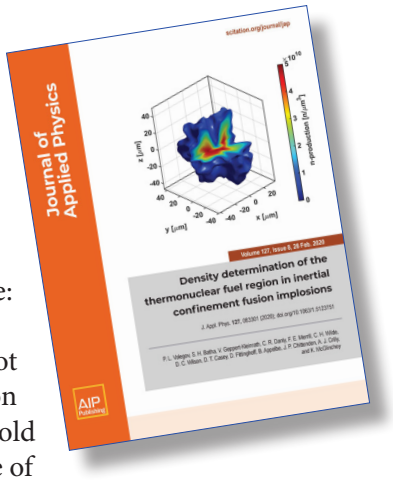
Be well and stay healthy,

Physics Division Leader Tanja Pietraß
Late May 2020

I really look forward to seeing you all in person hopefully soon—wearing a face mask and with overdue haircuts! I invite you to contact me with concerns, questions, and ideas that you may have—or just for a chat letting me know what you are up to!



Novel diagnostic cont.



The neutron imaging diagnostic, which uses primary and downscattered neutron images, now offers the opportunity to fully characterize the fusion fuel averaged over the burn-time: the limited-view 3D tomography of the burning hot spot and the novel information on the absolute density of the cold fuel. With density being one of the primary variables in the criteria for ignition, these data are ideally suited to draw conclusions on fusion performance in comparison to simulations.

Work is underway to develop suitable methods and standardized criteria for the community to effectively use the novel density data in comparison with radiation-hydrodynamics simulation output. The researchers are working with collaborators to identify these comparison criteria, which will aid in drawing further physics conclusions and place reliable uncertainties on additional physical quantities like pressure and temperature extracted from the data.

The work leverages the Laboratory's unique expertise in neutron imaging diagnostics development and data analysis. Diagnostic development includes modeling, designing, building, and characterizing the multi-aperture neutron imaging arrays and designing and fielding fast camera systems.

Reference: "Density determination of the thermonuclear fuel region in inertial confinement fusion implosions," *Journal of Applied Physics* 127, 8 (2020). Researchers: Petr L. Volegov, Verena Geppert-Kleinrath, Christopher R. Danly, Carl Wilde (Neutron Science and Technology, P-23); Steven H. Batha (Plasma Physics, P-24); Frank Merrill (formerly XTD Primary Physics, XTD-PRI, now Proton Radiography, P-26); Douglas Wilson (Plasma Theory and Application, XCP-6); Daniel T. Casey, David Fittinghoff (Lawrence Livermore National Laboratory); Brian Appelbe, Jeremy Chittenden, Aiden J. Crilly, and Kris McGlinchey (Imperial College).

This work, performed under the auspices of the DOE for the NNSA Inertial Confinement Fusion Science Campaign (LANL Program Manager John Kline), supports the Lab's Energy Security mission area and its Nuclear and Particle Futures science pillar. ■

Technical contact: Petr Volegov

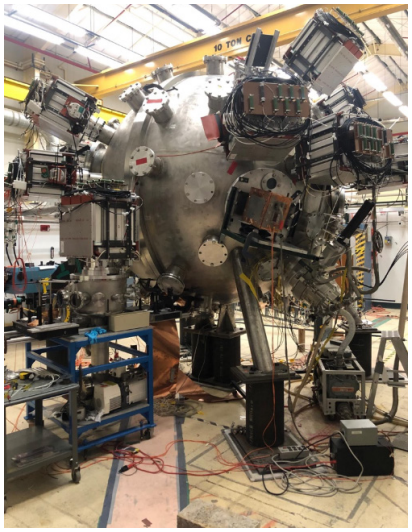
Physics Division news roundup

New funding for fusion concept research

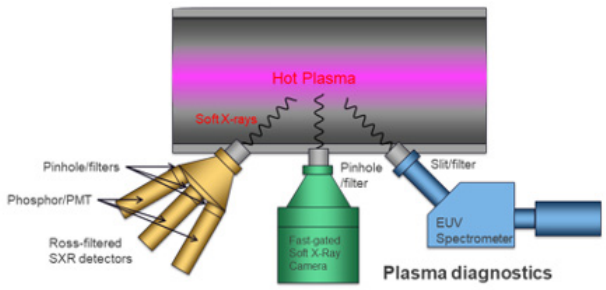
With an eye toward a grid-ready fusion demonstration within about 20 years, DOE is making significant investments in concepts that could help achieve cost-competitive, low-carbon energy. The goal is for fusion to contribute to meeting low-carbon energy demand in the latter half of the 21st century. The Advanced Research Projects Agency-Energy (ARPA-E)—which advances high-potential, high-impact energy technologies that are too early for private-sector investment—recently funded two Los Alamos concepts.

With that investment:

- Los Alamos scientists will research the concept of plasma-jet driven magneto-inertial fusion on LANL's Plasma Liner Experiment facility.
- A Los Alamos capability team will field plasma diagnostics to characterize the performance of some of the ARPA-E transformative fusion-energy concepts.



Half of the 36 supersonic plasma jets that will make up the Plasma Liner Experiment at LANL have been installed. The remaining jets will be added and fully spherical plasma liner experiments will commence by year's end.



LANL and the University of Nevada, Reno, will be providing four plasma diagnostics to one or more ARPA-E transformative fusion facilities, starting with FUZE and ZAP at the University of Washington in 2020. They will provide information on electron temperature, hot spots, and impurity radiation.

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News roundup cont.

The first project, a multi-institutional collaboration begun at Los Alamos by Scott Hsu (Physics Division Office, P-DO) and continued by Samuel Langendorf (Plasma Physics, P-24), was awarded $4.6 million as part of the Breakthroughs Enabling THermonuclear-fusion Energy (BETHE) program. In all, a total of 15 BETHE projects received funding.

Separately, a capability team, led by Glen Wurden (P-24) and consisting of LANL and the University of Nevada-Reno, will provide multi-chord spectroscopy and high-speed soft x-ray imaging diagnostics to the FuZE ARPA-E project (a flow stabilized Z-pinch experiment) in Seattle.

SC Graduate Student Research award brings Engel to HAWC project

Through a DOE Office of Science (SC) Graduate Student Research award, Kristi Engel, a graduate student in physics at the University of Maryland, will work with Pat Harding (Neutron Science and Technology, P-23) to research primordial black holes and gamma-ray bursts using the High Altitude Water Cherenkov (HAWC) Observatory. The program provides awards to outstanding US graduate students to pursue graduate thesis research at a DOE laboratory/facility in areas that address scientific challenges central to the Office of Science mission.

Thermal neutron research using Tinman detector receives 'best paper' award

Former Rosen Scholar Paolo Rech (co-authors Nathan DeBardeleben and Sean Blanchard, HPC-Design, HPC-DES) received the Best of SELSE (Silicon Errors in Logic-Systems Effects) award for their paper "Thermal neutrons: A possible threat for supercomputers and safety critical applications." Thermal neutrons were measured using the LANSCE Weapons Physics (P-27)/Intelligence and Space Research (ISR)-designed-and-built (Steve Wender, P-27, and Tom Fairbanks, Space Electronics and Signal Processing, ISR-4) Tinman detector, which is installed in the HPC computer room. The Laboratory Directed Research and Development program funded this work. The authors will present the work at a "best of" session at DSN2020 this month.

Meaney successfully defends doctoral thesis

Kevin Meaney (P-24) successfully defended his doctoral dissertation, "Cherenkov diagnostics on high-energy-density systems." Meaney, a 2019 LANL Distinguished Student Award nominee, is a physics PhD candidate at the University of New Mexico. His defense presented research that provides new, important insights into current National Ignition Facility experiments. His LANL advisors are Yongho Kim (P-24) and Hans Herrmann (Engineered Materials, MST-7).

EREBUS collaboration up for computational imaging 'best paper' award

Marc Klasky and Brendt Wohlberg (P-23) are nominated with their EREBUS team members for an IEEE (Institute of Electrical and Electronics Engineers) award for "best paper" in computational imaging. Development of advanced signal processing models to perform radiographic and tomographic analysis is of paramount importance to the Laboratory in supporting stockpile stewardship. They are implementing these techniques in their new code, EREBUS, as they move

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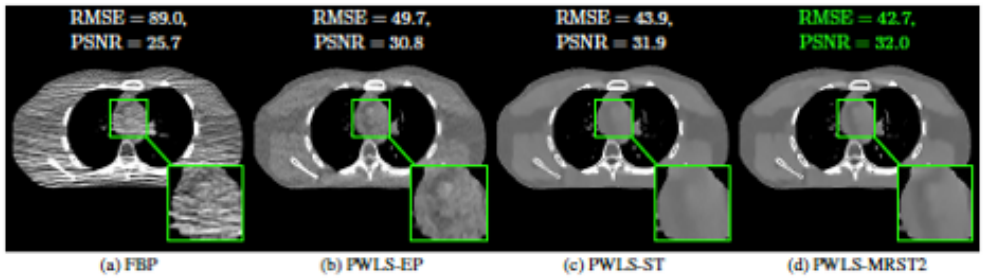


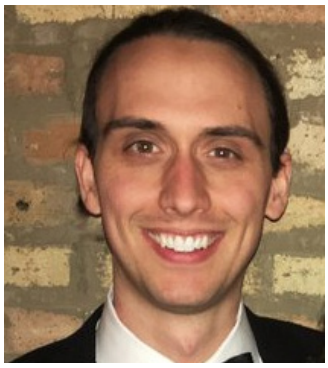
From the paper "Two-layer residual sparsifying transform learning for image reconstruction," a comparison of reconstructions of the XCAT phantom showing, from left to right, the improvement in the reconstructions using a newly proposed model for low-dose computed tomography image reconstruction.

Physics Division welcomes . . .

Hermann Geppert-Kleinrath
Plasma Physics, P-24

Hermann Geppert-Kleinrath joined the gamma diagnostics team in P-24 as a postdoctoral researcher in 2017 and converted to a staff scientist this year. He develops gamma detectors for the National Ignition Facility (NIF) and Omega Laser Facility, specializing in high-bandwidth gamma reaction history. Geppert-Kleinrath received his PhD in physics from the Vienna University of Technology, where he specialized in quantum mechanical measurement theory. He is a leading expert for pulse dilation technology and is now fielding the pulse dilation–PMT (photomultiplier tube) on the gas Cherenkov detector at NIF. He also provides gamma reaction histories for high yield NIF experiments and mix experiments at Omega.

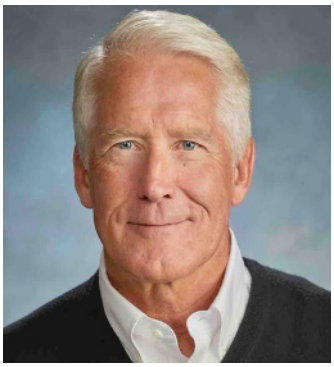
Luke Pfister
Neutron Science and Technology, P-23



Luke Pfister is a scientist on P-23's Radiographic Science and Analysis team, where he develops new algorithms and software for radiographic analysis and computational imaging. More generally, he is interested in machine-learning-inspired approaches to solving inverse problems.

He completed his PhD at the University of Illinois Urbana-Champaign and was a postdoctoral researcher in its Chemical Imaging and Structures Lab prior to joining LANL.

Harry Robey
Plasma Physics, P-24



Harry Robey joined P-24 in January. He is stationed at Lawrence Livermore National Laboratory (LLNL), where he assists and mentors P-24 personnel with the design and fielding of a wide range of high-energy-density physics (HEDP) experiments being conducted on the National Ignition Facility. These include experiments on radiation transport, opacity, multiple-shock interaction, and novel approaches to inertial confinement fusion (ICF). Prior to joining LANL, Robey was a physicist at LLNL for 33 years working on a wide range of problems in HEDP and ICF. He is an American Physical Society Fellow in the Division of Plasma Physics.

Wade Uhrich
Subatomic Physics, P-25

Wade Uhrich is a research technologist on P-25's Neutron team, where he assists with operations and maintenance of the helium cryogenics equipment and works with the team to meet its experimental goals. He previously worked at a manufacturing facility that engineered, assembled, and tested helium cryogenics' liquefiers, refrigerators, and compressors. Fun fact: Uhrich lived and worked in Los Alamos in the 1990s and is happy to have the opportunity to return to New Mexico.

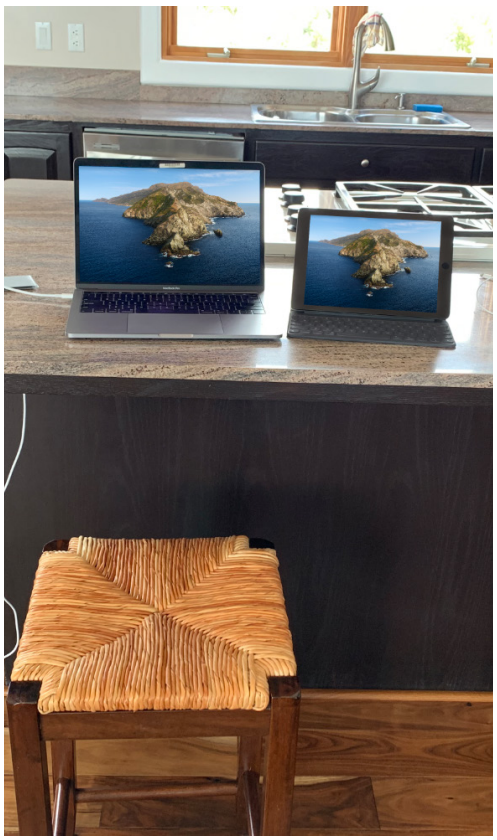
Additional recent new hires include Thomas White, Jr. (P-23), Lukas Zavorka (LANSCE Weapons Physics, P-27), and Jonathan Hudston (Proton Radiography, P-26).

Welcome all! ■

News roundup cont.

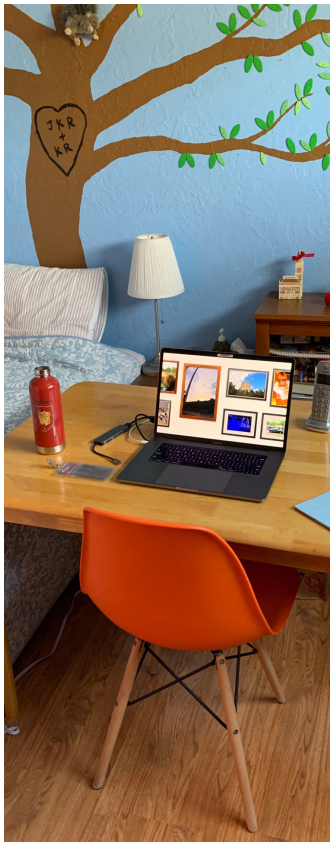
forward from the current method and to establish Los Alamos as a world leader in radiographic and tomographic reconstruction. In the process they continue to bring world-class employees to the Lab to join the EREBUS project as well as establish collaborations with top university programs. In the paper "Two-layer residual sparsifying transform learning for image reconstruction," the authors demonstrate the utility of pre-learning a two-layer extension of the transform model for image reconstruction, wherein the transform domain or filtering residuals of the image are further sparsified in the second layer. The proposed block coordinate descent optimization algorithms involve highly efficient updates. Numerical experiments demonstrate superior performance of a two-layer model over the previous related schemes for computed tomography image reconstruction from low-dose measurements. The researchers intend to incorporate this approach along with other state-of-the-art, physics-based, machine-learning algorithms to substantially improve upon the current empirical approach used to reconstruct radiographic data at DARHT, the Dual-Axis Radiographic Hydrodynamic Test Facility, and in the limited view reconstruction arena to allow for unsurpassed quantitative reconstructions. ■

Snapshots of working from home



Some Physics Division managers shared snapshots of their newly created home office set ups.

Can you guess who works where?



HeadsUP!

OPEXatLANL

The Lab's Operating Experience (OPEX) program captures and applies lessons taken from operating experiences internal and external to the Laboratory in order to avoid repeat events, anticipate and mitigate undesirable consequences, and replicate best practices. OPEXatLANL (opex.lanl.gov) is a one-stop resource for the most current and historical operating experience information, containing content that covers all elements and disciplines for the entire LANL community.

Celebrating service

Congratulations to the following Physics Division employees that recently celebrated a service anniversary:

Matthew Murray, P-23	45 years
Celine Apodaca, P-24	35 years
John O'Donnell, P-27	20 years
Russell Olson, P-23	20 years
Valorie Allison, P-23	15 years
Valerie Fatherley, P-24	15 years
Robert King, P-23	15 years
Marc Klasky, P-23	15 years
Eric Loomis, P-24	15 years
Mark Makela, P-25	15 years
Tim Medina, P-27	15 years
Sha-Marie Reid, P-24	15 years
Jason Allison, P-23	10 years
James Carroll, P-23	10 years
Jason Gochanour, P-27	10 years
Joan Siewenie, P-27	10 years
Lynn Kot, P-24	5 years

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SINCE 1943
Published by the Physical Sciences Directorate.

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